CORONAGRAPH OBSERVATIONS AND ANALYSES OF THE ULTRAVIOLET SOLAR CORONA

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Principal Investigator

Dr. John L. Kohl

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Wallops Island, VA 23337

Smithsonian Institution
Astrophysical Observatory
Cambridge, MA 02138

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The NASA Technical Officer for this grant is Mr. Larry J. Early, Code 840.0, Goddard Space Flight Center/Wallops Flight Facility, Wallops Island, VA 23337.

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INTRODUCTION

The major activities on the Spartan Ultraviolet Coronal Spectrometer project during the present reporting period include both scientific and experimental/technical efforts.

In the scientific area, a detailed analysis of the previously reported Doppler-dimming of HI Ly-α from our July 1982 rocket flight has determined an outflow velocity at 2 solar radii from sun-center ($R_\odot$) to be between 153 and 251 km/s at 67% confidence. That measurement can best be characterized as strong evidence of supersonic outflow within 2 $R_\odot$ in a coronal hole. Development of uv spectroscopic diagnostic techniques has continued with the publication of two papers on the interpretation of HI Ly-α line profiles, a review paper and several talks.

The technical activities have been very demanding. Following the preliminary integration activity at GSFC in 1986, several improvements were made to the instrument that will result in enhanced scientific performance or in regaining a capability that had deteriorated during the delay time in the launch date. Activities in the former category included testing and characterizing the detector for OVI radiation, characterizing a serrated occulter at uv and visible wavelengths, fabricating and testing telescope mirrors with improved edges, testing and evaluating a new array detector system, modifying the slit mask mechanism and installing a mask in the instrument to block the Ly-α resonance line when the electron scattered component is being observed. Each of these improvements has been implemented in the instrument. It has been necessary to replace several devices which degraded during the delay time. The replacement effort has proven to be time consuming. All of the telescope mirrors were replaced, recoated, re-installed and aligned within the telescope mechanism. The entire instrument was then realigned. The vac-ion pump on the OVI detector became erratic due to wear and was replaced. The photocathodes could not be exposed to air during the replacement process. Tests were required (in vacuum) before and after the replacement to ensure that the detector was not damaged. Several electronic components experienced random failures and had to be replaced. These potted components are difficult to replace and the diagnostics to identify faulty components are more difficult when potting is present. The flight vacuum gauges failed and required testing and maintenance. These are just a few examples of the efforts required to maintain an instrument of the Spartan class during the extended delay.

Also during the delay, the instrument experienced problems with the high voltage power supplies used to power the vac-ion pumps. These high voltage/high current supplies proved to have a faulty design. We spent a considerable effort procuring and testing appropriate power supplies for this purpose.

In order to ensure that the instrument could be maintained over a prolonged period, the documentation, especially that describing the electronics, was upgraded to an appropriate level.

The instrument has now been shipped to GSFC for integration with the White Light Coronagraph (provided by HAO) and the Spartan Instrument Carrier and Service Module. We expect that it will be returned to SAO in May 1989 when it will go through a full characterization, calibration and stray light evaluation. The characterization includes laboratory simulations of the new diagnostic technique for electron temperature. This activity is expected to take eight to ten months. Final observing programs will then be written and the associated master sequencer list will be delivered to GSFC. We expect to deliver the instrument for final integration checks at GSFC about six to eight months before launch. Following the first flight, we will carry out a full radiometric calibration and characterization to establish the instrument characteristics during the flight.

The following scientific papers were presented and/or published during the report period:

1. Esser, R. and Withbroe, G. L., "Effect of a Quiet Background on Line Observations from Coronal Holes", presented at meeting on Activity in Cool Star Envelopes, Tromso, Norway, (1987). Published in conference proceedings.

2. Withbroe, G. L., "Physics of the Corona and Inner Solar Wind", colloquium presented at NASA Goddard Space Flight Center.

3. Kohl, J. L., Weiser, H., and Livi, S., "Spectroscopic Measurements of Solar Wind Parameters Near the Sun", presented at Yosemite conference on Outstanding Problems in Solar Plasma Physics: Theory and Instrumentation. To be published in conference proceedings (in press).

4. Withbroe, G. L., "The Temperature Structure, Mass and Energy Flow in the Corona and Inner Solar Wind", Astrophys. J. 325, 442 (1988).

5. Esser, R. and Withbroe, G. L., "Line-of-Sight Effects on Spectroscopic Measurements in the Inner Solar Wind Region", J. Geophys. Res. (1988), in press.

6. Gardner, L.D., Kohl, J.L., Weiser., H., Strachan, L., Fisher, R., and Sime, D., "Observations of the Extended Solar Corona from a Spartan Carrier,", Bull. Am. Astron. Soc. 21, 840 (1989).

7. Strachan, L., Kohl, J.L., Munro, R.H., and Withbroe, G.L., "Doppler Dimming Measurement of Solar Outflow," Bull. Am. Astron. Soc. 21, 840 (1989).

UVCS results also stimulated several other research papers and lectures including:

"Models for the Corona and Inner Solar Wind", by G. L. Withbroe, presented at the meeting of the AAS Solar Physics Division in Hawaii (1987);

"Acceleration of the Solar Wind as Inferred from Observations", invited paper by G. L. Withbroe, presented at Solar Wind 6 and published in the proceedings;

"The Solar Wind Mass Flux", by G. L. Withbroe, Astrophys. J. 337, L49 (1989);

"The Solar Wind and Its Coronal Origins", invited paper by G. L. Withbroe, W. C. Feldman, H. Ahluwalia presented at conference on The Solar Interior and Atmosphere, submitted for publication (1989).

SCIENTIFIC RESULTS FROM THE PRESENT REPORTING PERIOD

The major efforts in this area during the reporting period were: 1) a detailed study of the UV and white light measurements from the 1982 rocket flight, 2) a review paper by Kohl, Weiser, and Livi, 3) two papers on the interpretation of Lyman alpha line profiles, and 4) a paper which used rocket Lyman alpha and other data to construct solar wind models.

In the July 20, 1982 rocket flight of the UVCS, Lyman alpha and white light measurements were acquired in a large, polar coronal hole. A detailed analysis and interpretation of these data has been carried out by L. Strachan for a major section of his Ph.D. dissertation. Measurements of the profiles and intensities of the resonantly scattered hydrogen Lyman alpha radiation (from UVCS) have been analyzed in conjunction with electron densities derived from the white light measurements (from the

HAO WLC). A model of the terrestrial exosphere was calculated in order to correct the intensities and line profiles for the effects of absorption and emission of Lyman alpha by the geocorona (Withbroe et al. 1985, Astrophys. J., 297, 324). The geocoronal model calculations were checked using the Lyman alpha measurements at 3.5 $R_\odot$. In the coronal hole the measurements at 3.5 $R_\odot$ appear to be dominated by the geocoronal emission. The latter can be distinguished from coronal emission by its narrow profile. The intensities were calibrated using the preflight radiometric calibration. [A careful analysis of the preflight and postflight calibrations and the measurements acquired during the flight showed that the instrument calibration most likely changed during reentry due to contamination caused by the melting of the insulation of a WLC cable which rested on the inside of the rocket skin. The cable was damaged due to excessive heat being absorbed.]

The Lyman alpha profiles at 2.0 $R_\odot$ are non-symmetrical. Given the large flow velocities expected (from the Doppler-dimming measurements discussed below), a likely explanation for the profile shape is that the coronal component is Doppler-shifted with respect to the geocoronal emission by the line-of-sight component of the coronal outflow velocity.

The detailed analysis of the Lyman alpha intensities suggest that they are strongly Doppler-dimmed at 1.5 and 2.0 $R_\odot$. That is, the intensities predicted for a static model are three to five times larger than observed. A careful examination of the various sources of error suggests that the Doppler-dimming at 2.0 $R_\odot$ indicates an outflow velocity between 153 and 251 km/s with 67% confidence. This takes the uncertainties in the model (e.g. uncertainties in the electron density, electron temperature, and geocoronal correction) as well as the measurement uncertainties into account. The uncertainties in the rocket measurements do not support a determination at a 90% confidence level (i.e., 1.8σ). [The uncertainty is expected to be much lower with Spartan measurements, because of the larger number of parameters measured, including the electron temperature, and much better statistical accuracy of the data.] Details of this analysis are given in Strachan's thesis, which is in preparation. J. Kohl, H. Weiser, and S. Livi presented a review paper at the Yosemite conference on Outstanding Problems in Solar System Plasma Physics: Theory and Instrumentation. The paper, entitled "Spectroscopic Measurements of Solar Wind Parameters Near the Sun", will be published in the conference proceedings. The abstract is as follows: "Instrumentation ... and plasma diagnostic techniques ... are being developed to obtain a detailed empirical description of solar wind acceleration regions at heights between the coronal base and about 10 solar radii from sun center ($R_\odot$). The goal of this work is to determine a sufficient number of observational parameters to constrain, significantly, theories of solar wind acceleration, coronal heating and solar wind composition. Although a substantial amount of data on the electron density structure of the corona already exists, there are only isolated measurements of other critical plasma parameters, except for observations of regions near the base of the corona ($r < 1.3\ R_\odot$)."

Ultraviolet spectroscopy provides a capability to expand greatly the number of plasma parameters that can be specified by means of remote sensing techniques. Ultraviolet measurements of spectral line profiles determine the random velocity distributions and effective temperatures of protons, minor ions and electrons. Ion densities, and chemical abundances are derivable from the collisional component of the observed resonant line intensities. Outflow velocities can be determined from Doppler shifts and Doppler dimming of spectral lines. R. Esser and G. Withbroe have been studying the interpretation of coronal line profiles made in coronal holes which are surrounded by denser regions. The results have been reported in two papers: (1) "Effect of a Quiet Background on Line Observations from Coronal Holes", presented at a meeting on Activity in Cool Star Envelopes, in Tromso, Norway, and published in the conference proceedings, and (2) "Line-of-Sight Effects on Spectroscopic Measurements in the Inner Solar Wind Region", to be published in the Journal of Geophysical Research.

The abstract of the latter paper states: "The effect of the integration along the line of sight on the spectral line profiles of the resonantly scattered Lyman alpha radiation emitted by low density coronal holes at heights above 1.5 $R_\odot$ is investigated. It is shown how the spectral lines from this region are influenced by the Lyman alpha emission from surrounding regions with higher densities. The coronal hole and the surrounding areas are described by a two-fluid solar wind model. It is shown that the line-of-sight effects can be important for the interpretation of the Lyman alpha spectral line measurements in the outer corona and solar wind." The paper also discusses how the shapes of spectral line profiles and tomographic techniques can be used to separate emission components from the coronal hole and surrounding regions. These techniques are applicable to any optically thin coronal line observed at the limb.

Measurements of coronal Lyman alpha emission played an important role in a major study of the inner solar wind by Withbroe. This paper, "The Temperature Structure, Mass, and Energy Flow in the Corona and Inner Solar Wind", was published in the Astrophysical Journal. The abstract reads as follows: "Data from remote-sensing and 'in situ' instruments are used as empirical constraints on a radiative energy balance model in order to determine the radial variations of coronal temperatures, densities and outflow speeds in several types of coronal holes and in a quiet, unstructured region of the corona. The one fluid solar wind model used in the investigation includes the effects of radiative and inward conductive losses in the low corona and the chromospheric-coronal transition region. It satisfactorily accounts for a variety of measurements of coronal and solar wind parameters for an equatorial coronal hole, polar coronal holes at solar minimum and solar maximum, and an unstructured quiet region of the corona. The results indicate that the total nonradiative energy input in magnetically open coronal regions is $5 \pm 1 \times 10^5$ ergs cm^{-2} s^{-1}. Most of the energy heating the coronal plasma appears to be dissipated within 2 $R_\odot$ of the solar surface with a characteristic dissipation length which varies approximately as P_0^α, where P_0 is the pressure at the base of the corona and $-2 < \alpha < -1$. The results of the study also provide insights for future development of a comprehensive physical model for open magnetic regions which can account for the low densities in coronal holes and the generation of low- and high-speed solar wind."

SUMMARY OF EXPERIMENTAL/TECHNICAL ACTIVITIES

The major technical activities during the report period consisted of implementing the modifications to the instrument resulting from the 1986 preliminary integration and test activity at NASA/GSFC, testing and evaluating the new discrete anode array detector and integrating it into the UVCS payload, testing the OVI detector and integrating it into the payload, testing the serrated edge occulter system, procuring and testing replacement high voltage power supplies for the detector vac-ion pumps, running limited thermal tests on the complete system, undertaking final preparations of the instrument, shipping the UVCS to NASA/GSFC, integrating the UVCS with the WLC experiment at NASA/GSFC, co-aligning and co-registering the UVCS with the WLC, integrating the experiments with the Spartan 201 spacecraft, running functional tests on the Spartan 201, and carrying out environmental testing of the Spartan 201 payload including vibration testing, magnetic calibration, EMI testing, acoustic testing, mass property measurements, and thermal-vacuum testing.

The new discrete anode array detector for HI Ly-α, which replaced the earlier unit that had suffered unacceptable gain losses, was delivered to SAO by the Ball Aerospace Systems Division in November 1986. Subsequent to its arrival at SAO, a series of subsystem tests were performed on the array. These included measuring the pulse height distribution, dark count rate, resolution, cross-talk, count rate linearity, count rate statistics, system counting efficiency, and cathode uniformity. The optimum high voltage settings for the MCP and field electrodes were determined and set. The noise characteristics of representative channels were determined, and the lowest threshold for reliable operation was established and set. Subsequent to the above, the detector was installed in the spectrometer, optically aligned, and several tests were repeated. In evaluating the cross-talk among the 90 anodes in the detector, the cross-talk between the fine anodes, between the coarse anodes, and between the fine and coarse anodes was examined. These cross-talk tests resulted in several modifications to the instrument to enhance performance: the entrance slit for the narrow HI Lyman-α line was reduced in height, a mask, which lowered the cross-talk by almost an order of magnitude, was installed immediately in front of the detector to block light falling on the central two coarse pixels and the disk mask was modified to open-up the 12 μ pinhole to approximately 1 mm which will now allow the instrument to make an independent T_e observation.

The OVI detector high voltage cable was potted at the detector, and the vac-ion pump associated with the detector was replaced with a new flight unit. The cross-talk induced by the OVI detector into array detector electronics, a problem which had been discovered during the last reporting period, was evaluated, and the preliminary amplifier discriminator electronics were modified to eliminate the problem. The optimum threshold settings for the OVI detector were determined, and the detector subsystem tests and radiometric calibration were repeated to verify performance. Following these activities, the detector was installed in the spectrometer and optically aligned.

The serrated edge occulter system was designed, the serrated units procured, and laboratory testing carried out to compare the new serrated system with the straight edge system used on the previous rocket flights. Test results indicated approximately an order of magnitude improvement in the stray light suppression at visible wavelengths (5000-6000 Å) and approximately a factor of four improvement at λ1235 Å. In light of these results, the serrated edge system was incorporated into the Spartan instrument.

The search continued for an alternative high voltage power supply to power our

Vac-Ion pumps during and immediately preceding flight. A vendor with personnel experienced in manufacturing similar power supplies for use in aerospace applications was selected, and an order for three units (2 flight plus 1 spare) was placed with them in November 1987 for an early 1988 delivery. Unfortunately subsequent to receiving the order, this particular company experienced serious financial difficulties and was unable to deliver the supplies despite SAO's efforts to expedite the order. Another search for an acceptable supplier was undertaken, and an order was placed for three power supplies in early December 1988. These units were delivered to SAO in late January 1989, tested, and integrated with the Spartan payload in February 1989. After a week or so of operation in the UVCS, the units began failing. GSFC undertook an analysis of the failures and traced the faults to cracks, most likely caused during assembly, in the insulation on the supplies' high voltage output connectors. The problem is being corrected.

During mid-1988, limited thermal testing was undertaken on the complete instrument and two potentially serious problems were uncovered. The first involved the telescope mirror assembly. It was determined that relatively small excursions in temperature caused the two telescope mirrors to tilt with respect to each other in such a way that the instantaneous field-of-view of the resonantly scattered Ly-α profile would no longer coincide with the field-of-view the OVI intensities. The cause of the problem was located, the mirror assembly was modified, and the solution was verified via repeated testing.

The second temperature related problem was associated with the flight electronics. The failure manifested itself in a lack of response to inputs from the flight system GSE, and the GSE display would fail to show updated housekeeping data. The interval between failures was random, although temperature related. At ambient temperatures below 27°C the system appeared reliable while above this temperature the system would fail repeatedly. The primary cause of the problem was traced to a defective filter capacitor in the 5 volt power supply for the memory board. In the course of tracking down the bad capacitor, two minor logic problems on the memory board and controller board were found and corrected.

Several changes were made to the flight software. All inadequacies noted during the preliminary integration have now been corrected. Software to read the temperature sensors and include them in the PCM stream was developed, tested, and verified. Overall software verification continued, and verification aids were improved. Software to simulate some abnormal operating conditions was developed in order to test the system's ability to respond to these conditions. A hardware-software watchdog timer was implemented which resets the electronics if an abnormal lack of activity is detected. Some software simplifications were made.

In the electronics area, a major effort went into updating the electronics documentation. This included generating a complete set of cable drawings, and reviewing and updating all electrical schematics. Payload hazard reports for the Phase 2 Flight Safety Package were completed and returned to GSFC. The analog housekeeping and temperature sub-multiplexer system, which are located on the Analog Housekeeping board, were calibrated. Spare disk drives for the GSE system were ordered and checked out. A flight spare for the Memory/ACS Interface board was fabricated and tested. The UART board, which is used primarily during ground operations, was loaded with high-reliability components, tested, and installed in the flight system so as to increase the overall system reliability. The calibrated sun sensor (LISS) was received from NASA/GSFC, installed on the UVCS, and the associated UVCS pointing alarm circuitry was calibrated and tested. The passive PCM simulator GSE interface cabling was replaced with the TDP interface system, and the UVCS GSE was modified accordingly.

The cold cathode vacuum gauge was completely refurbished, tested, calibrated, and installed in the instrument to provide vacuum readings when the system is evacuated.

Thermal vacuum tests were run on the disk mask mechanism to verify that this unit would operate in vacuum for longer periods than originally planned. There appears to be no problem, and this system will be operated for approximately 40 minute intervals twice during the mission when making the T_e observation.

The discovery of deterioration of the mirror coatings forced the procurement of new telescope mirrors. Prior to initiating fabrication, several methods of minimizing light scattering off the critical edge of the mirror were evaluated, and the optimum approach was incorporated into the new mirrors.

At that time, it was determined that it would be valuable to the program to have a spare mirror arm assembly complete with a full complement of optics installed but uncoated. This would allow us to coat the optics very close to the time of launch with less of an adverse impact on the UVCS integration schedule, and thus allow for a quicker turn around in the future should the mirror coatings have to be replaced again. The spare components were ordered and have been fabricated and fit-checked. The remaining task involves potting the uncoated optics into their mirror cells. A new mirror potting fixture to minimize contamination of the optics by the potting process was also designed, fabricated, and tested.

Several areas related to the laboratory facilities were also improved during this period. A small vacuum chamber (0.75 meter diameter by 1.2 meters long) was transferred to the UVCS program and refurbished to provide another vacuum test chamber to allow tests on various components to proceed in parallel. The diffusion pump originally used with this chamber was replaced with a new 400 liter/sec horizontal turbomolecular pump provided at no cost to the program. Other horizontal turbomolecular pumps used on the large vacuum calibration system were refurbished. A new X-Y-Z-θ vacuum compatible, computer driven, motorized positioning system was provided at no cost to the program and has been used extensively in testing and calibrating various elements of the system. Several new TC gauges and controllers as well as an ionization gauge controller and associated gauges were also provided at no cost to the program and have been used effectively on both of the vacuum calibration and test facilities. Both vacuum chambers were thoroughly cleaned, and calibrated contamination monitor mirrors were procured to allow for controlled contamination monitoring of both chambers. A filter system for the purge line was purchased and installed on the large vacuum chamber in order to minimize particulate contamination of the system during vacuum venting operations. The clean showers associated with the large vacuum chamber were refurbished and relocated to maximize cleanliness in the vicinity of access openings. The monochrometer associated with the large vacuum chamber was also refurbished and fitted with a new VUV hollow cathode light source including a differential pumping unit, which was provided at no cost to the program. An automated safety vent-up system for the small vacuum chamber was designed, fabricated, installed, and tested. A similar system will be provided in the future for the large vacuum system. A new remotely driven collimator mirror drive assembly was designed and fabricated to replace the existing drive, which has had a history of failures. In addition, a light trap, to minimize stray light from the monochrometer, was designed, fabricated, and installed behind the new collimator assembly.

Prior to shipment to NASA/GSFC, all components of the UVCS instrument that had been removed since the return of the system to SAO were replaced and aligned as required. This involved a complete realignment of the optical system including all mirrors, gratings, internal and external occulters, sunlight traps, LISS assembly, and alignment flats.

The system was prepared for shipment to NASA/GSFC, and arrived at GSFC on 31 October 1988. Subsequent to arrival, the system was unpacked and functionally tested to assure that no damage occurred in transit. The UVCS was then coaligned with the WLC instrument, and a coregistration was performed. The interface between the UVCS electronics and the Spartan 201 ACS and PFCS systems was verified, and the electronics were installed in the Spartan Service Module (SM). The combined UVCS and WLC experiments were mounted into the Spartan Instrument Carrier (IC), and the IC was mated with the SM. A vacuum test on the fully integrated IC was performed, and SAO verified detector performance at VUV wavelength using the new calibration bulkhead, which was designed and fabricated by SAO and included a new portable deuterium light source provided at no cost to the program.

Following this successful calibration test, the Spartan was transported to the test facilities and exposed to flight level vibration. Subsequent coalignment and coregistration checks of the instruments showed that movement had occurred during the shake, and modifications were made to the NASA provided alignment fittings on the IC-instrument kinematic mount. After a second vibration test, coalignment checks showed no external mechanical movement, but coregistration checks again showed that movement appeared to have taken place between the two instruments. At this time it is thought that this may be due to an internal movement of the WLC CCD detector which is coupled to the fin on the IC.

In early March the full-up Spartan 201 system underwent a magnetic calibration and then proceeded to EMI testing. Acoustic testing and mass properties were carried out near the end of March 1989. Mission profile tests at ambient temperature and pressure are planned for early April, and thermal-vacuum tests on the full-up system for late April. It is expected that the UVCS will be returned to SAO in early May.

INTEGRATION AND TEST ACTIVITIES

Reassembly of the instrument was completed at SAO. Included was installation of the OVI detector, the telescope mirrors and drive, the sunlight trap, and the detector amplifier box, development and implementation of a scheme for heat sinking the disk mask solenoid, the setting of the Ly-α grating to first order, and the setting of the OVI grating to zeroth order. Functional tests of the disk mask and telescope mirror mechanisms were carried out. Electrical tests of the detectors and their acquisition electronics were done. The detectors were also checked to make sure they could respond to ultraviolet light. The Flight System Controller was checked for correct performance. The ground support equipment (GSE) was also checked. After verification of correct performance, the instrument and supporting equipment were packed for shipment to GSFC.

Upon arrival at GSFC, functional tests were again carried out prior to co-assembly of HAO's white light coronagraph (WLC) with our ultraviolet coronal spectrometer (UVCS). No malfunctions were found. The two instruments were put into a measured alignment condition and then incorporated into the Spartan 201 spacecraft. The assembled spacecraft was then sent to Goddard's vibration facility where it was vibrated at protoflight levels. Although all systems internal to the UVCS successfully passed the vibration test, the relative alignment of the UVCS and WLC changed by approximately one arc-minute, an amount considered unacceptable. Engineering changes in the mounting system were incorporated by GSFC. The instruments were then re-mated, aligned to an accuracy sufficient for launch, and reassembled into the Spartan Instrument Carrier. The Instrument Carrier was returned to the vibration test facility where it underwent tests to flight levels. The second test was successful, relative alignments having held to within a tolerance of 10 arc-seconds. Again no malfunctions of systems internal to the UVCS were noted. There continue to be problems with the co-registration of the two instruments at about the one arc minute level.

Two 4-hour tests of the full Spartan system were carried out. No failures of the UVCS systems were noted during the tests.

New high voltage power supplies for operating the vac-ion pumps on the detector systems have been acquired and installed. Although problems have been encountered with the new supplies, we believe we understand the difficulties and find the supplies to be completely satisfactory, once the difficulties are corrected.

The Spartan 201 spacecraft was entirely assembled. It underwent magnetic calibration tests at GSFC's magnetic test facility. EMI testing was also completed. Acoustics testing and weight and center of gravity measurements were done during the last week of March. Mission profile and thermal-vacuum tests are planned for the month of April.

ELECTRONICS ACTIVITIES

During the period of time from April 1987 to March 1989, progress on the UVCS electronics has been made in several areas: the flight system, the GSE, and in documentation.

Flight System

Several things were done to the preamplifier-discriminator boards. Ten channels of coarse pixels which had previously not been implemented were configured using new Amptek A-111's. Thresholds of these were set to match the other channels. Two coarse channels which had been disabled, C19 and C22, were re-enabled. It was found that the OVI detector was causing some cross-talk with the channels adjacent to it on the PAD circuit boards due to the large size of its output signal. It was thus necessary to design and install a network to reduce the signal before it entered the board.

In the analog housekeeping system, some channels were found to be susceptible to noise. Filtering was added as required. Thermal housekeeping channels were modified to give consistent scale factors. Finally the analog housekeeping board was recalibrated.

Calibration data for the LISS on the UVCS was obtained from GSFC. This data allowed us to set upper and lower limits for the error signals that we receive from the

LISS. In the interest of reliability, we decided to replace the limit-setting trimpots with fixed resistors. Since we ignore roll errors, we also decided that the ACS roll signal alarm circuit should be disconnected

Two trouble areas consumed a large amount of time. The flight system was found to be subject to a sporadic loss of synchronization. This manifested itself so infrequently that troubleshooting was difficult. The problem was traced to a power supply filter capacitor on the memory board. This capacitor was sent out for analysis and was determined to have been of faulty manufacture. Since replacing it we have had no more incidents. The other problem area involved the high voltage power supplies that power the ion pumps on our detectors. We experienced some difficulty in finding and obtaining suitable power supplies. We currently have three units that have gone through portions of the integration activity at NASA/GSFC. Unfortunately all three of them have experienced failures during integration. The cause is a defect in the high voltage connectors on the supplies' outputs. The supplies otherwise are rugged and completely suited to our application. We are at present negotiating with the manufacturer for their replacement.

GSE

Most of the work on the GSE was done to prepare for our integration at GSFC. Because of the new clean room that was built for our integration, we were forced to make new interface cables between our GSE and the flight electronics. The new arrangement has the flight system in the clean room and the support electronics in an adjacent control room. The cables must now go through the wall via bulkhead feedthroughs, and are about fifty feet in total length. To accommodate this increased length, the GSE electronics were modified to add line drivers.

Some redesign was done on the interface between the Goddard TDP system and our GSE. This interface lets us read the PCM data stream when the UVCS is integrated in the Spartan service module. In the past, hooking up the TDP interface was a cumbersome procedure. The modification makes it much simpler and more reliable.

Documentation

A significant amount of effort went into improving the documentation for the flight electronics system and GSE. All electrical drawings were reviewed and updated. Areas that had been changed via handwritten notes were clarified. The form in which we keep cable and interconnection information was changed. Originally they were kept in wire run lists which were organized in notebooks. The method proved to be difficult to use and to maintain. The system was changed so that all wire lists are now entered into electrical drawings and are under the same configuration control as all other UVCS drawings. The reorganization has been completed for the flight system and is underway for the GSE.